NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

AN INFORMATION ANALYSIS AND SOFTWARE DESIGN
FOR A PERSONAL COMPUTER-BASED MESSAGE MANAGEMENT SYSTEM

by

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March 1987

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SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b RESTRICTIVE MARKINGS
2a SECURITY CLASSIFICATION AUTHORITY	3 DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution is unlimited
2b DECLASSIFICATION/DOWNGRADING SCHEDULE	
4 PERFORMING ORGANIZATION REPORT NUMBER(S)	5 MONITORING ORGANIZATION REPORT NUMBER(S)
6a NAME OF PERFORMING ORGANIZATION Naval Postgraduate School	6b OFFICE SYMBOL (If applicable) 32
7a NAME OF MONITORING ORGANIZATION Naval Postgraduate School	
6c ADDRESS (City, State, and ZIP Code) Monterey, California 93943-5000	7b ADDRESS (City, State, and ZIP Code) Monterey, California 93943-5000
8a NAME OF FUNDING/SPONSORING ORGANIZATION	8b OFFICE SYMBOL (If applicable)
9 PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER	
8c ADDRESS (City, State, and ZIP Code)	10 SOURCE OF FUNDING NUMBERS

PROGRAM ELEMENT NO	PROJECT NO	TASK NO	WORK UNIT ACCESSION NO

11 TITLE (Include Security Classification)
AN INFORMATION ANALYSIS AND SOFTWARE DESIGN FOR A PERSONAL COMPUTER_BASED MESSAGE MANAGEMENT SYSTEM

12 PERSONAL AUTHOR(S)
Dahlmeier, Michael C.

13a TYPE OF REPORT	13b TIME COVERED	14 DATE OF REPORT (Year, Month, Day)	15 PAGE COUNT
Master's Thesis	FROM TO	1987 March	65

16 SUPPLEMENTARY NOTATION

17 COSATI CODES			18 SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	Software Design

19 ABSTRACT (Continue on reverse if necessary and identify by block number)

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20 DISTRIBUTION/AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS	21 ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED
22a NAME OF RESPONSIBLE INDIVIDUAL Daniel R. Dolk	22b TELEPHONE (Include Area Code) (408) 646-2260 · 22c OFFICE SYMBOL 54DK

DD FORM 1473, 84 MAR — 83 APR edition may be used until exhausted. All other editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE

AN INFORMATION ANALYSIS AND SOFTWARE DESIGN FOR A PERSONAL COMPUTER-BASED MESSAGE MANAGEMENT SYSTEM

by

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Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN TELECOMMUNICATION SYSTEMS MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL
March 1987

ABSTRACT

Recent improvements in Naval Communications electronics and the automation of a significant portion of message processing has done much to reduce the problem of writer-to-reader delay. What delays that still remain are the time-consuming manual message preparation processes that are concentrated at the message drafter and transmission preparation phase. This thesis analyzes the outgoing message preparation process from message creation to electronic transmission with respect to speed and accuracy. System and User requirements are translated into a preliminary software design for personal computer-based Message Management system. The design methodology used is a combination of Structured Design Technique and Hierarchical Input-Process-Output (HIPO) to show system relationships and documentation of module contents.

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I. INTRODUCTION

A. PURPOSE

This thesis was undertaken to analyze the current deficiencies in processing of outgoing communications messages by afloat commands with respect to speed and accuracy prior to actual transmission within the communications network and to propose a software design for use at the message drafter level. It is directed to the individual with reasonable understanding of the Navy's current message preparation procedures and basic experience in software design and documentation.

B. PROBLEM STATEMENT

The minimization of writer-to-reader delays in communication messages is a primary goal of the Naval Telecommunications Command's Automation program [Ref. 1: page 1-1]. The introduction of computers into the communication system has significantly increased the ease of message processing and transmission which, in turn, has allowed the demand for information, command and control to utilize the communication system at a significantly higher rate. The resultant increased message traffic volume and computer processed message forms has placed the burden of writer-to-reader delays on the manual processes of message drafting and transmission preparation.

Current research in the area of improving writer-to-reader delay and reduction of errors has focused on major system improvements to shore based communication station message processing equipment and at improvements to afloat message transmission and receiving accuracy and reliability. Significant equipment improvements to afloat units are generally restricted by space and/or funding limitations. What improvements that have been made are almost entirely within the communication center itself. The installation of distributed message processing systems onboard ships has been strictly limited to aircraft carriers or large command ships. The need for an off-line message processing system for ship-board office use by message drafters has been largely ignored leaving them to devise their own procedures for creating and verifying outgoing messages. The need for a message processing aid to reduce both processing time and errors by message drafters and communication centers still exists.

As the microcomputer revolution sweeps into the Navy through formal acquisitions and personally owned microcomputers brought onboard, the suitablity of this available resource for use as a message processing aid is most readily apparent.

C. ANALYSIS OBJECTIVES

In conducting the analysis of the message preparation process, the main concern was to identify those time-consuming manual processes that could be combined and placed at the message drafter level with the aid of a personal-based computer. An examination of each step in the message preparation process focused on where improvements in speed and accuracy could be achieved and where redundant processes could be eliminated. The objective of the analysis was not to seek a departure from the current flow of message preparation, but rather to enhance it through the use of automation.

D. PROJECT DESIGN OBJECTIVES

The primary objective of this program design was utility by message drafters. Utility refers to how easy the software is to use. It is critical to consider the interaction of man and machine in the analysis phase, and continue using this perspective in the design process. New methods and tools are difficult to accept over established procedures unless the simplicity and benefit of those methods and tools are readily apparent. Bulky operations manuals and complicated command sequences would drive away even the most ardent computer user. Additionally, the design should have familiarity to the user incorporating established message drafting practices into the logic of the design. The drafter should be able to see the logic of the program as he moves through the process and gain confidence in its use by relating the program to already familiar procedures.

Other design objectives were portability and understandability. Portability refers to how easily the program can move from operating system to operating system. The numerous personal computers now being used by message drafters encompass several different operating systems and versions thereof. As a result, the design cannot be dependent on a particular operating system to be of any significant use to the Navy.

Understandability refers to how easily the design documentation, structure, modules, and code can be understood by the users, programmers, and maintainers. The adapting or enhancing of the software after its delivery must be a major concern in it's preliminary design. Consequently, clarity and simplicity, modularization, structured

programming, straightforward algorithms, and good documentation must be used to improve understandability and thus maintainability of the program.

E. ORGANIZATION

The remainder of the thesis is structured as follows: Chapter 2 is a brief background review of the Navy's Telecommunication's Automation Program and previous studies conducted in the area of outgoing message preparation. Chapter 3 presents an analysis of the outgoing message preparation process in a step by step methodology. Alternative solutions are described and reviewed as to their respective merit. Chapter 4 is the design of the Message Management System. System requirements are defined and discussed. A system structure is presented and program components described. Chapter 5 discusses the implementation and coding of the Message Management System. The appendices provide more detailed program structure charts and HIPO diagrams.

II. BACKGROUND

A. INTRODUCTION

The automation of message processing functions in afloat communication centers has occurred almost entirely within the last 20 years. In order to appreciate the significance of the problem and to gain a perspective on Message Processing Systems a review of the Navy's Telecommunication Automation Program is considered necessary. This chapter summarizes the beginning of the NTAP and its objectives, and describes previous studies conducted by the Navy on the problem of outgoing message preparation.

B. NAVAL TELECOMMUNICATION AUTOMATION PROGRAM

In the past, the heavy volume of military communications traffic and the increasing demand for near-instantaneous, world-wide delivery capabilities created an urgent need for much more capable message processing and delivery systems than known, currently existing, manual or semi-automatic systems.

In an effort to satisfy this critical requirement, various military commands and developing activities (including commercial interests), through the application of various "state-of-the-art" techniques, proceeded independently to develop some degree of automation in communications systems. This rash of uncoordinated developmental activity resulted in a proliferation of partially automated systems that had varying degrees of effectiveness with limited fields of application.

This fragmented approach, lack of in-depth analysis of common methods and requirements along with the absence of standardized system/engineering concepts, necessitated extensive modifications at considerable cost in terms of time and money.

As a result, in August 1973 the Chief of Naval Operations directed the consolidation of various afloat automation programs under a single program coordinator and a single program director and required development of a consolidated Subsystem Project Plan for afloat automation. The subsystem project plan was called the Naval Telecommunications Automation Program.

The Department of Defense has set forth certain objectives relative to consolidation and realignment of communications networks. Objectives now achieveable through the use of automation for effective command and control include improvements in accuracy, security, and reliability.

The Naval Telecommunications Automation Program was established to set in motion the Department of Defense objectives. The primary objective of the NTAP is to satisfy existing and future requirements for speed, accuracy, security and reliability of record information transfer through automation of the Naval Telecommunication System in the most economical manner possible. Initial emphasis concentrates on the automation of those functions which provide the greatest impact on writer-to-reader time and efficient use of personnel resources. The NTAP provides for the evolution of the NTS into an automated system with standardization of hardware and software, both ashore and afloat, that will satisfy all Navy record information transfer requirements. More specific objectives of the NTAP are:

* Improve writer-to-reader times to acceptable standards.
* Reduce error rates through elimination of manual operations.
* Allow real-time connectivity between processors for command and control applications.
* Provide a capability to effect facility consolidations and reduction of dedicated telecommunications requirements.
* Reduce communications functions performed and minimize communications equipment aboard ship to the maximum extent possible.
* Reduce requirements for communications personnel.
* Make maximum use of high-speed data links (AUTODIN and satellites). [Ref. 1: page 1-1]

C. PREVIOUS STUDIES

The manual message processing functions associated with the preparation of an outgoing naval message are numerous and time-consuming. As the volume of message traffic increases, the requirement of preparing a message for transmission becomes a significant task for the message drafter and the afloat communication center. Restrictions on funding, man-power, and space onboard ships limit the means to alleviate the ever-growing problem.

The inefficiencies described have been recognized by the Navy for some time, and several studies were made to determine how to best solve the problem. Some of the more recent studies are summarized below.

1. Shipboard Communication Automation Review (SCAR)

Completed in October 1978 at the direction of the Director of Naval Communications (OP-941), this review was conducted in two phases. The first gathered data from the fleet concerning perceived needs and validated stated

requirements. The second phase correlated the fleet's expressed requirements with existing and planned systems. Thirty-three ships and seventeen operational staffs from both fleets were visited in the data-gathering effort. Significantly, the manual tape-cutting process was deduced to be the biggest single impediment to efficient processing of outgoing messages. According to the study a tape had to be cut at least three times on the average before achieving a transmission-quality tape, a figure which most people with communications center experience would find realistic.

The study concluded that ships with medium to heavy traffic loads needed an improved method of outgoing message preparation. Alternatives considered included OCR readers, online Keyboard Video Display Terminals (KVDT) or a stand-alone KVDT. A stand-alone KVDT which could eventually be integrated as an on-line unit was ultimately chosen as the most desirable option.

One interesting conclusion drawn from a brief analysis of the previous related study was that bottlenecks in message flow had moved from ashore to afloat message centers because of improvements in the communication path (i.e. the use of interference-free UHF satellite paths instead of HF) and the automation of ashore communications systems at a faster rate than shipboard equipment. [Ref. 2]

2. Message Preparation Device Study

This study was completed in July 1979 by OP-941 and was an extension of the previously described SCAR, focusing on outgoing message preparation in large ships. Its purpose was to review the requirement for a message preparation device, evaluate alternatives and recommend a near term course of action. It was to be followed nine months later by a similar study for small ships, which will be described in the next section. The approval of these studies led to the current Message Preparation Device (MPD) program. The study determined a number of important characteristics in an automated message preparation device, among them:

* Easy input of standardized items (date-time group, time of file, classification, etc.)
* Storage of one or more messages in process.
* Simple correction and editing.
* Compatibility with existing and programmed systems.

Systems evaluated were the UGC-6 with peripheral processing storage and control units, the AN/USQ-69 Keyboard Video Display Terminal (i.e. the standard NAVMACS on-line terminal), the commercially available Teletype Corporation's

Model 40, and the Aimes OCRE. Analyzed were ease of use, system costs, (both one-time and recurring costs), durability and maintenance, etc. The UGC-6 was eliminated on the basis of age of equipment, increased maintenance costs, and inherent inefficiency of operation. The OCRE was eliminated on the basis of an admittedly subjective estimate of delicacy, excessive costs, and the relative inefficiency of an OCR typewriter compared to a KVDT. Of the remaining KVDT systems, the USQ-69 was deemed superior essentially because it was already Approved for Service Use (ASU) whereas the Model 40 was not.

The study's main recommendation was that the USQ-69 be adopted as the standard message preparation device for large ships beginning in FY-80, and that OCRE be further investigated as an interim measure. (As of 1984, an OCRE, brand name Compu-scan, was installed in at least one east coast CV, USS Saratoga). It further recommended that message preparation devices be considered for destroyer and smaller sized ships because while smaller ships have lower message volumes they also have fewer people, and the increase in efficiency might well justify the cost of automated equipment.

3. **Message Preparation Device Study for Small Ships**

This study was completed in January 1980 by OP-941 and was a specific response to the recommendation in the preceding study that message preparation devices should be evaluated for smaller ships. Systems evaluated were the USQ-69 KVDT in both on-line and stand-alone configurations, the Teletype Model 40 KVDT in both configurations, the Electronic Communications Incorporated (ECT) Model T-1148 and the Data Projects Model MXT 1200, the latter two being Keyboard Printers in a stand-alone configuration. After a thorough analysis of costs and capabilities, the two Keyboard Printers and the Teletype Model 40 were eliminated because of the lengthy cycle of getting them Approved for Service Use. The principal distinction between the on-line and stand-alone configurations of the USQ-69 was that the on-line configuration permitted direct entry of a message into NAVMACS (vs. outputting, then reading, a paper tape) and also permitted use of the NAVMACS AN/UYK-20 computer for some administrative details, such as detection of format errors. The on-line configuration required less space than the stand-alone configuration because the former could time share NAVMACS peripherals (printer, paper tape punch etc.) while the latter required dedicated peripherals. Not surprisingly, the study strongly recommended the AN/USQ-69 in the on-line configuration, with the stand-alone configuration as the next desirable alternative.

D. SUMMARY

As shown in this chapter, the Navy has recognized both the problems in the outgoing message process, and the value of automation as a possible solution. The goal of reducing writer-to-reader delay is most likely accomplished through the use of computers in the automation of the communication process. In the next chapter, an analysis of the outgoing message preparation process with respect to the susceptibility of its automation is discussed.

III. ANALYSIS

A. INTRODUCTION

The manual message processing functions associated with the preparation of an outgoing naval message are numerous and time-consuming. As the volume of message traffic increases, the requirement of preparing a message for transmission becomes a significant task for the message drafter and the afloat communication center. Restrictions on funding, man-power, and space onboard ships limit the means to alleviate the ever-growing problem. In this chapter an analysis of the message prepartion process is presented to identify the processes required to produce an outgoing message as well as the mechanics involved. Alternative methods of preparing an outgoing message are considered and reviewed as to their respective merit.

B. PREPARATION PROCESS

Currently, manual and semi-automatic methods are employed in telecommunication centers and communication stations for the processing of messages into and out of the communications networks. Message processing includes accomplishment of all tasks manually that are associated with (1) preparing, routing and formatting messages for input into the communications networks; (2) the validation, segregation and onward transmission of messages to and from afloat units; (3) the receipt, editing, internal routing, reproduction and distribution of message output from the communication networks; and (4) the filing, retrieval or retransmission of messages previously processed by the system. In this analysis, we are concerned specifically with the first task of preparing, routing, and, formatting messages into the communication network.

The manual outgoing process begins with the message writers, whose smooth drafts are routed up through the chain of command for review and releasel for transmission. The released draft is delivered to the command's message center where it is logged into the center, assigned a date-time-group, and checked for address accuracy and completeness. The final message draft is then passed to the form conversion operator (usually a tape-cutter), who converts them from draft to transmit form, rechecks them for accuracy and passes them to the supervisor for transmission release. The supervisor double checks the message for proper completeness, then passes them

to the circuit operator for transmission on the circuit specified. Records and logs are kept throughout the outgoing process.

C. MESSAGE PROCESSING FUNCTIONS.

The process of handling messages involves many common discrete functions. The purpose of this section is to provide a description of these functions to establish a baseline. This enables an understanding of the analysis in subsequent sections of this chapter. Processing an outgoing message through a command requires four separate phases: (1) Message drafting, (2) Routing, (3) Logging, and (4) Conversion to a transmittable form. Each phase is governed by a set of procedures or instructional guidelines that establish the set requriements for entry into the next phase. Figure 3.1 depicts these phases with controlling functions shown entering the phases from the top, Responsible personnel or activity entering from the bottom, Input to the phase from the left, and Output to the right.

1. Drafting

Preparing a draft and obtaining a release are the drafter's responsibilities. This is accomplished through a procedure called Message Staffing which refers to the the drafter's procedure to verify his proper use of message formats, validity of the information contained within the message, proper classification and downgrading instructions, and an accurate and complete addressee list.

a. Formatting

For proper message format the drafter must refer to various communication manuals depending on the type of message he desires to send. Message formats fall into two broad catagories called Structured and Pro Forma. Structured refers to the overall standard appearance of a message and the required sequence of information contained therein. Pro Forma refers to a particular type of structured message.

Today's Naval Messages are processed by at least one computer in the transit to their final destinations, and in the case of computer formatted contents, the message may go to a computer for action. Formatting errors in message formats, addresses, or content format result in the message being "kicked out" of the system to be either processed by hand, or returned without delivery for proper formatting. In either case, it is an embarrassment to the initiating command and an added delay in the writer-to-reader process.

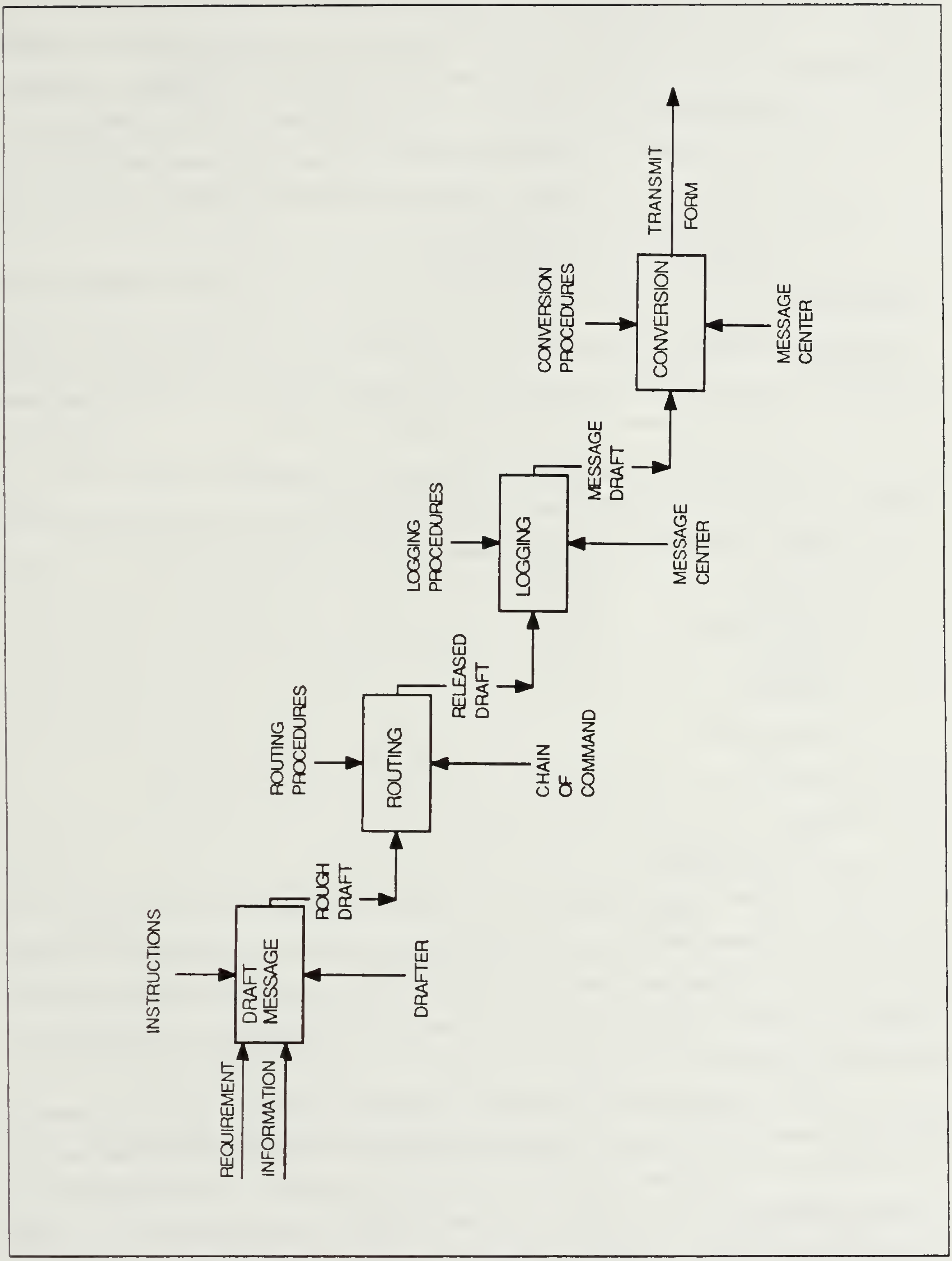


Figure 3.1 Outgoing Message Process.

Pro Forma messages are messages where specific information always appears in the same location of the message body. Casualty Reports (CASREPS), Unit Reports (UNITREPS), and Movement Reports (MOVREPS) are examples of Navy pro forma messages. For example, the first line of a CASREP is identified by the words "MSGID CASREP/" followed by the message originator and the message originator's Navy Reporting Structure (NRS) serial number. This reported information always appears in the same location in the text.

Constructing messages in the pro forma manner is advantageous because such a process

enhances processing of the data, both manually and by the computer. Message drafters preparing pro forma messages must adhere precisely to instructions for textual construction and assignment of addressees (refer to NWP-7).

Classification markings are not applied to paragraphs, sub-paragraphs, and subject lines when the overall classification and declassification markings are displayed on the following pro forma messages: (refer to OPNAVINST 5510.1(G))

* MOVREP
* EMPSKED
* CASREP
* UNITREP
* RAINFORM
* MERCO
* EAM

b. Classification

Proper classification of a message is critical to the security of the information contained therein and the distribution of that information to the personnel who require it in the performance of their duties. Improper classification can do damage to National goals on one side, and deny critical information to personnel who need to be informed on the other.

Classification of a message is accomplished by the classification of individual paragraphs within the message and the classification of the message as a whole derived by the highest classification within the message. Improper classification of paragraphs is the most common error committed by message drafters. A complete understanding of the message classification portion of OPNAVINST 5510.1(G) is required to properly draft a message. Availability of OPNAVINST 5510.1(G) is a

problem since limited copies are provided to afloat commands and constant revisions by message and mail make a valid copy of the instruction almost unique. However, standard classification procedures remain virtually intact despite recent upheaval. These classification requirements might be made available to the drafter as part of a Message Management System, it could improve security of message content.

c. Plain Language Addressee (PLA) Verification.

Most drafting errors frequently involve Plain Language Addressees. The only authorized source of short titles and geographical locations in message addressees in the Plain Language Address Directory (PLAD) disseminated and controlled by COMNAVTELCOM as NTP-3 SUPP-1. The PLAD is intended for the use of message drafters and is not solely a communications center tool. [Ref. 3: ART 03.08.0400]

Drafters tend to copy addressees as spelled on incoming messages. Invalid PLAs cause manual intervention at NAVCOMPARS with resultant delay in writer-to-reader time. Even when time is taken to verify correct PLAs, NTP 3 SUPP-1 does not include NATO addressees nor many joint addressees. Therefore, the task of PLA verification normally becomes the responsibility of the Communications Center. The large bulk and sparse availability of NTP 3 SUPP-1 makes its use by message drafters uncommon.

d. Standard Subject Identification Code

The Standard Subject Identification Code (SSIC) is included in the message classification line and indicates the subject matter of the message. Distribution of the message at large commands are based upon the SSIC and improper or missing SSICs can cause non-delivery of the message to the intended reader. Most drafters in the process of preparing an outgoing message take the SSIC from the message they are replying to or place a general SSIC such as N00000 (Administration, General) or N03500 (Operations, General) into the message. This practice tends to defeat the purpose of the SSIC and degrades the speed and accuracy of message processing and delivery. The SSIC Manual is another limited available reference guide rarely found outside the command's Personnel Office or Communication Center.

2. **Routing**

Routing consists of checking the message through a predetermined chain of responsibility to the releasing authority. If the drafter is the releasing authority, then this is evidently quite simple. Most likely, this is not the case and as the message is

reviewed by each designated person. errors that are noticed are corrected. The review's purpose is to verify the requirement for the message, validate the message format chosen. and insure the accuracy and appropriateness of the contents of the message. The releasing authority is the final review of the draft for content. Experience is the key factor here in the detection and correction of errors. Additonally, the message form lends itself to either aiding or hindering error detection. Handwritten messages are the most likely to have undetected errors or misinterpretations that lead to errors. Typed messages present a more positive appearance with less chance for misinterpretaion, but in doing so, may cause message reviewers to be lax in their error checking.

Once the routing requirement has been satisfied, and the message released for processing to transmit, the message is delivered to the communication message center.

3. **Logging**

Once the message has been delivered to the message center, it is entered in the message log by some combination of drafter, originator, addressee, precedence, subject, and date-time-group (DTG). If the message had not been previously assigned a DTG, it is assigned at this time. The draft is then reviewed for proper structure and completeness of information. The addressees are verified against the NTP 3 SUPP -1 directory for accuracy and currency. Based upon the message's precedence, it is queued to the form conversion operator for transmit preparation.

4. **Conversion to a Correct Transmission Form.**

Messages are received in various forms. They can be handwritten or typewritten on message forms, including Optical Character Reader (OCR) forms. On nearly every ship the messages are taken by a Radioman to a paper tape cutting device (AN UGC-6 Teletypewriter) and a tape is prepared. (A few ships have a paper tape cutting device located in supply or flag spaces which permit delivery to the message center in a tape form). After the tape is prepared it is passed through the UGC-6 to get a valid printed copy. Another radioman then compares the printed copy against the original message for any typing errors. If errors occur, then the tape must be passed through the UGC-6 again to obtain a fresh paper tape. Ship studies have confirmed NELC TD305 and the Ranger measurements. (See Table 1) which indicated messages longer than 350 words (average length) require correction nearly all of the time. Shorter messages require tape correction about 80 percent of the time. Tape

correction requires reading the tape back through the UGC-6 and generating a fresh tape until the error is encountered. The tape reader is then stopped and the error manually corrected. The duplication process continues until the entire tape has been reproduced. This results in handling each message several times. For each time it is handled it passes through a queue for the next step.

TABLE 1

USS RANGER TAPE CUTTING SURVEY

Sample No.	1	2	3	4	5	6	7	8	9	10
First Cut in Minutes	19	4	27	4	11	11	4	2	20	2
Number of Cuttings	4	3	2	2	6	3	6	3	6	4
Total Time in Minutes	48	15	29	15	65	18	14	30	72	20
Sample No.	11	12	13	14	15	16	17	18	19	20
First Cut in Minutes	5	10	2	5	14	5	5	3	4	3
Number of Cuttings	3	3	3	5	2	2	4	2	3	1
Total Time in Minutes	9	30	10	17	25	25	22	15	17	19
Sample No.	21	22	23	24	25	26	27	28	29	30
First Cut in Minutes	5	6	6	3	3	7	3	5	19	5
Number of Cuttings	2	2	3	2	2	3	2	4	8	2
Total Time in Minutes	13	15	12	15	13	24	7	26	75	35

[Ref. 2: page 5]

D. MEASURES OF EFFECTIVENESS

To get a better feel for what is expected by way of speed and accuracy in outgoing message preparation, a means of measuring the effectiveness of the process is necessary. The two methods provided by the Navy Communication System are the Speed of Service Criteria and the Manual Intervention Rate.

1. Speed of Service

The maximum delay objective for handling messages is published in ACP-121 US Supp-1(e) and NTP 3(B). These standards apply to the processing of the message within the communication organization. The present measure of effectiveness for speed of service is applied from the time a message is given to a message center released for transmission, until the time it is available for delivery at the addressee message center. ACP-121 establishes maximum time as follows:

Precedence	Flash	Immediate	Priority	Routine
Allowed Time	10 min	30 min	180 min	240 min

The limiting factor in message handling as measured by ACP-121 is the preparation (the typing) function. It does not take into account the time required by the message originator to draft and route the message through the release authority to the communication center for transmission. The SCAR study (summerized in chapter 2) determined that the average amount of time required to process an outgoing message from drafter to transmission was 75.5 minutes. Forty minutes, or slightly over half of that time, was required for the actual drafting of the message. The next significant time delay was the conversion into a correct transmission form. This involved another eighteen minutes of the overall time. Message proofreading, and addressee verification took another nine minutes of the total time, leaving 8.5 minutes for message's delivery to to the communication center, Date-Time-Group assignment, and circuit transmission time. Figure 3.2 gives a visual breakdown of the time requirements discussed.

If the speed of service requirement was measured from the drafter (writer)-to-reader, the standards established by ACP-121 would have to be significantly revised. A more realistic standard covering the entire process would be as follows:

Precedence	Flash	Immediate	Priority	Routine
Allowed Time	20 min	120 min	210 min	300 min

This standard is compatible with existing expectations of the Navy. OPREP-3 messages, which are the most common Flash precedence messages known, require a

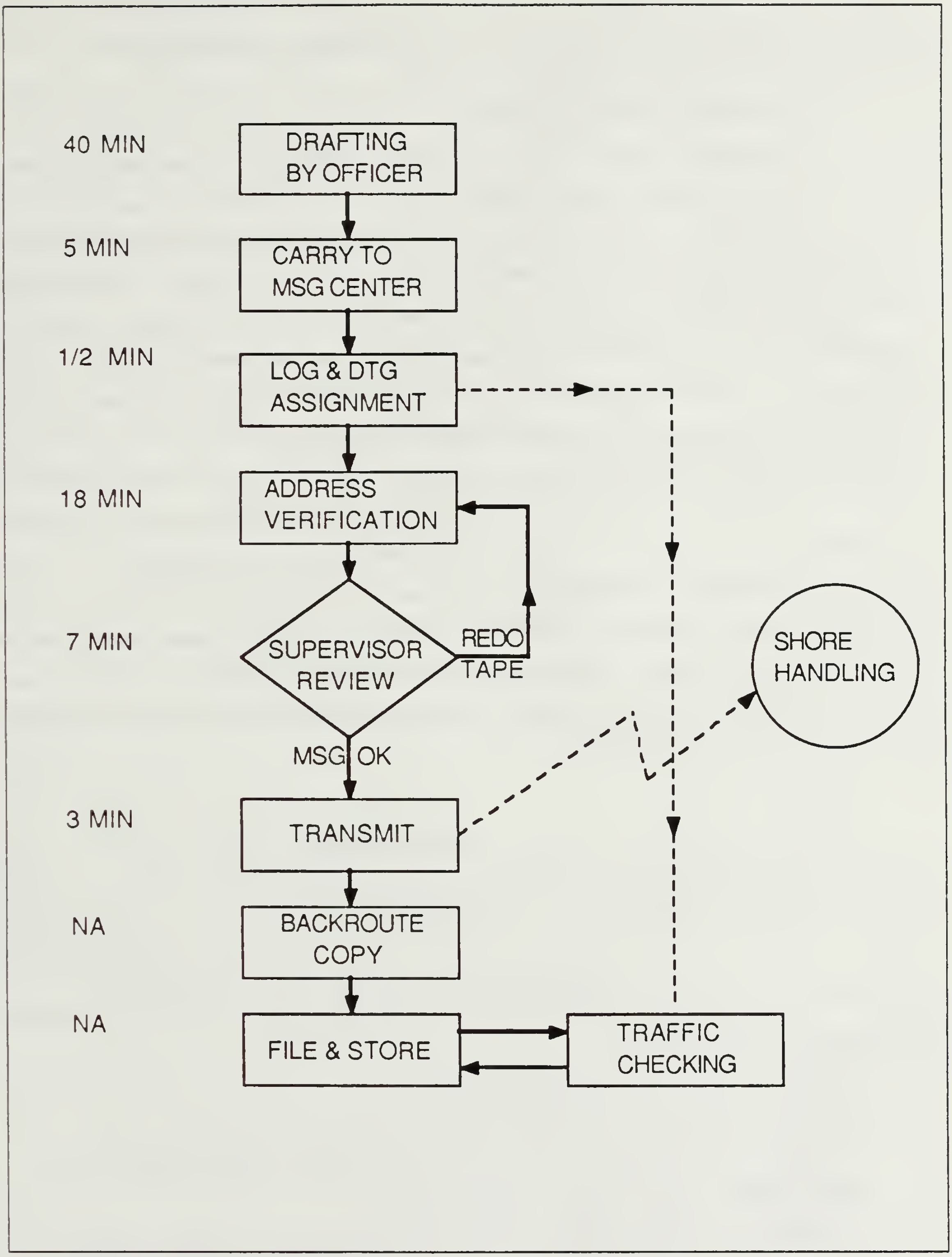


Figure 3.2 Message Processing Time Requirements.

hard-copy (message) within 20 minutes of the incident necessitating the message. Immediate messages must be transmitted within 1 hour, priority within 4 hours, and routine within 8 hours unless otherwise specified.

2. **Manual Intervention Rate(MIR)**

Manual Intervention rates are a measurement of the percentage of delays of messages due to originator error with respect to total message volume. MIR's are closely monitored and reported to NTC and the originating command by Communication Improvement Memorandums (CIMs). CIMs are official documents used to inform message drafters, releasers, and processors of message drafting and or procedural errors. The MIR percentage rate not to be exceeded by an activity is established at 5 percent with 1 percent as goal [Ref. 3: ART 03.08.0800]. The fleet wide MIR has improved from approximately 14 percent in 1980 to 7 percent in 1985. Outgoing message traffic from afloat commands account for about 20 percent of the total MIR. [Ref. 4] As described in the SCAR study, only 9 minutes or 7.9 percent of the outgoing message process is dedicated to verification of a message's correctness. One's first impression is that this time is apparently not enough to do the job properly. However, keeping in mind the problem of reducing writer-to-reader delay, this time should be reduced along with the Manual Intervention Rate. The solution lies in either removing the process from the error-prone human or reducing the number of errors prior to human verification.

E. ALTERNATIVES

Virtually all narrative messages to and from ships are sent in machine readable form thus eliminating the use of Morse Code. However the method now used to prepare the punched paper tape that a teletypewriter can read is slow, antiquated and tedious. There are, four alternative ways to prepare traffic for transmission. All of these methods use keyboard entry devices. The methods are listed here and discussed and compared in this section:

* Punching a paper tape with an AN UGC-6
* Preparing a DD-173 OCR Form which can be machine read.
* Typing on a stand-alone Keyboard Video Display Terminal (KVDT) which
* can generate a paper tape or magnetic tape.
* Typing on a KVDT connected on-line to a message processing computer.

1. **Tape Cutting.**

The AN UGC-6 consists of a printer, keyboard, tape reader, and two tape perforators. A message is first prepared by typing the message on the keyboard. As errors are encountered, they are corrected through a series of backspacing and "lettering out" of the wrong characters on the tape. ("Lettering out" is the term applied to the process of "erasing" a character by punching all five holes in the tape representing the non-printing "letters" character). After the message has been prepared, the tape is passed through the UGC-6 again to get a smooth printed copy. A second man then checks the message by reviewing the smooth page copy. Any errors remaining are then corrected by reading the tape back into the unit where it simultaneously punches another new tape and prints a page copy. Errors are corrected by a series of manual manipulations of the tape reader, backspaces and "lettering out". Thus messages prepared in this fashion generally require at least one additional correction pass, as indicated in Table 1 .

a. Manual Input Speed Limited

The UGC-6 has an upper speed limit which restricts the operator from exceeding approximately 66 words per minute. The average radioman cannot sustain such a speed. The best operators generally attain only 40 words per minute, and the average operator usually prepares the initial tape at about 20 WPM. This "lock out" feature on the UGC-6 prevents average and above average radiomen from realizing their full speed capabilities.

b. Tape Corrections During Entry

The universal need for tape correction requires backspacing and "lettering out" the tape. The operator must keep track of the number of functions which have been erroneously punched.

c. Tape Correction After First Tape is Prepared.

Correcting the tape after it is cut requires the use of the UGC-6 paper tape reader. The operator must be quick to be able to stop the reader at exactly the right point every time. Should he miss the desired character, it requires additional time to visually read the tape while in the reader, backspace the original and corrected tape, "letter out" the errors and then restart the original tape. The tape must be read through the UGC-6 and duplicated at a speed of 100 words per minute until the error is found, corrected, and then the remainder of the tape is duplicated.

d. Tabulated Data.

Messages with tables are difficult to prepare on the UGC-6 because it is not possible to manually move the printer to the desired location. All printer movements must be made through the keyboard. Radiomen tend to delay the preparation of long messages with extensive tabulated data.

e. Limited Equipment Assets.

In general all of the tape cutting devices are located in the message center which tend to centralize the message preparation function. This causes bottlenecks during periods of heavy message loading.

f. Three-row Keyboard

All current teletype equipment use a three-row keyboard (with numbers represented as upper case alphabetic characters) which require an orientation period.

2. **Optical Character Reader**

The OCR, which uses the DD-173 form, solves many of the problems described under tape cutting. Important items relating to OCR include:

a. Natural Keyboard

The messages can be prepared on normal typewriters which have a four-row keyboard. This allows a typist to prepare messages at normal typing speeds.

b. Easy Correction

Correction techniques are easier because the OCR font includes a "blob" or "Christmas Tree" character which, when typed over the erroneous character, causes the OCR reader to ignore the character. This process eliminates the need to keep track of the number of backspaces, particularly when the error may be several words or lines back in the text.

c. Correction of Post Preparation Errors

Correcting of errors after the page has been prepared is simplified. The deletion and substitution of words is relatively easy through the use of white paste-on correcting tape. This permits the operator to "erase" lines or paragraphs without the necessity of retyping the page which is required when a new word or paragraph is to be added and there is no space.

d. Tabulated Data.

Tabulated data are easy to prepare on the DD-173 because most typewriters have a tabulation feature. In addition, the operator can position the carriage manually, which is not possible with tape cutting equipment.

e. Equipment

Many typewriters with an OCR capability exist in the fleet. The OCR method permits messages to be prepared anywhere on the ship.

3. On-Line Video Display Terminal

These devices consist of a keyboard and a video display device. In addition, they can include a printer and or a magnetic tape device. The combination can also be associated with a paper tape unit which provides the capability to prepare both a magnetic tape input media (for high speed), and a paper tape input (for low speed and compatibility between all existing systems). This technique has many of the advantages over the OCR technique. Items worthy of consideration include:

a. Natural Keyboard

Natural Typewriter keyboard input is used with no upper limit on the input typing speed.

b. Simplified Corrections

Correction of errors is simplified because KVDT devices allow the operator to literally move characters and lines by means of a set of edit controls. These include inserting or deleting characters and lines.

c. Various Output Formats

The KVDT prepared message can be printed on paper, recorded on magnetic tape, or punched on paper tape which makes the message readable by an automated system.

d. Equipment

These devices are generally more expensive than typewriters and will not be in every location on a ship where there are now typewriters.

4. Off-Line Microcomputer (KVDT)

The fourth alternative is to use an off-line microcomputer with messages manually passed to the communication center in three possible forms; Printed copy, Punched Paper Tape, or DD173 Optical Scan Form. The retention of the physical message form compares with current methods, along with the manual delivery of the message through the "chopping" process to the communication center. This alternative would decrease message drafting time through use of message processing software, increase the accuracy of formats, PLAs, and SSICs through software libraries, and ease the manual man-power intensive procedures of the communications center through legible message drafts, reliable PLAs and formats, and reduction in form conversion to

a transmittable form. No major hardware purchase is required, nor is any significant installation of equipment or cable network necessary. Of the four alternatives presented, this provides the quickest, cheapest, and easiest solution to the message processing problem. Microcomputers are already in the Navy's inventory and personally owned computers exist onboard ships in significant numbers.

F. SUMMARY

Speed and accuracy are two requirements that summarizes the concerns of the communication message processing system and the users who draft the input. The time consuming manual procedures currently employed can be significantly improved through the use of automation. The most likely alternative for a a quick inexpensive solution to the problem is an application program for a personal computer. The software must consider both the accuracy requirements of the system and the needs of the user with respect to speed, capabilities, and ease of use. In the next chapter, the software design for such a program is presented.

IV. PROPOSED DESIGN

A. INTRODUCTION

The analysis of the previous chapter delineated the procedures and mechanics for preparing an outgoing message. In this chapter, those processes are combined, structured, and described in the logical sequence of a software design method. Design concerns, methodology, and descriptions are presented as a possible preliminary system design of a "Message Management System".

B. DESIGN REQUIREMENTS

In designing the "Message Management System", the intended use of the system onboard U.S. Navy vessels yielded some unique requirements that are of vital concern to an implementation effort. These concerns cover every phase of the outgoing message proccess and need to be presented as requirements criteria for the design of the system.

1. Equipment Portability.

A ship-based Message Management System cannot take up a lot of space because there is not that much available space on a ship. The system must be small and portable to be of any use to the command. Space limitations and weight restrictions dictate that the system be composed of microcomputers for desk top use. The portability is also essential for probable storage of the system during extreme weather, hostilities, or to provide more desk space to other functions when the system is not in use. Portability would, in addition, allow a greater number of users (if the system was compact enough), or be readily adaptable to a change in organization or mission. Expansion of departmental offices, reallocation of office spaces, or redirection of mission emphasis (thus changing message generation points) are possible changes that might require the locational movement of a microcomputer.

2. Security

MMS Security can be divided into three categories. (1.) the physical security of the system; (2.) the information access control to the computer's memory or memory storage devices; (3.) the electronic emission security of the system called TEMPEST in Navy terminology.

a. Physical Security

Physical security would be a major concern of any MMS computer system. As a result of the microcomputer's size, there is a problem related to mobility. For a MMS to be successful, the hardware for the system must be located in the user's work areas. This decentralization complicates security problems. The threat of theft is directly proportional to the security attitude of the ship. A tight quarterdeck watch that inspects all off-going items and a roving security patrol would greatly reduce the occasional unauthorized transfer of the machines.

Another security method would be to affix the micro permanently to the surface of a desk or table. These devices are manufactured by several firms. Some devices provide for the micro to be unlocked for repairs.

Lastly, there is a method of putting all micros into a secure area after working hours and have access controlled by either a security lock or watch. Such a method can be the most cumbersome of the physical security methods and the one most prone to machine damage from its daily travels between workspaces on a ship. It also does not guarantee the security of the machine during working hours if left unattended for a brief moment.

Physical security of floppy disks or cassette tapes deals with protection against theft, destruction, or damage. Floppy disks or cassette tapes with sensitive data files should be locked away in fire resistant containers in a secure place. Even floppies or tapes with totally encrypted files can be picked up and carried away.

b. Information Security

Information security is the next level of concern as the sensitivity of the information contained in the micro's memory and on disks or tapes can range from unclassified supply requests to top secret operational plans. All personnel that have access to the machines may not have access to certain information contained therein. Software and physical devices are available to provide all manner of access structure. An almost trivial security technique for floppy disks or cassette tapes is to lock them away. Various software packages provide password protection for files. Passwords properly managed and controlled can be effective in handling casual access. Passwords assigned to individuals and periodically reviewed for currency can be very effective.

Data encryption may be regarded as the ultimate defense. Some manufacturers combine control of physical access with passwords and data encryption. Whole hierarchies of file control can be built with different individuals having access to

various files or groups of files. Each encrypted file can only be decrypted by the encrypter or others with the appropriate key. Data which is encrypted is virtually impossible to decrypt without "the" key.

c. Electronic Security

Another major concern of information security is spurious electronic transmission from the system that can be detected by an external listening devices. Computers, peripherals, and wiring may require shielding to prevent these transmissions from being monitored by hostile surveillance. The level of classified information that can be entered into the system may have to be restricted. This particular form of electronic security is called TEMPEST and is of significant concern to the Navy. Current technology has already produced "TEMPEST CERTIFIED" microcomputers for use on Navy ships.

3. **Simplicity**

Even though the level of computer knowledge is rising in the world, the need for a simplistic system is essential to get the most benefit from the greatest number of users. There are still a significant number of people who find sitting at a computer terminal the most frightening thing of their lives. This fear is brought on by the unknown, to wit, how to work the system. Step by step processes must be used with user prompts provided by the system. An accompanying users's manual should follow the program through it's major path and then offer alternatives once the major path has become familiar. User prompts and action codes should be closely associated with the action desired. (e.g.) To edit a message, type EDIT; to print a message, type PRINT; to see the available form messages; type FORMS, etc. These simple codes, along with system prompts for input, help, or error correction must all appear to the user as assisting him/her in preparing the message. Short cuts, advanced message manipulation, or increased capability should be available, but left as an optional addition, not as a requirement to use the system effectively.

The popular Wordstar word processing program provides an excellent example of system prompts and assistance. A section of the screen is used to display various action codes that can be used and the capability to receive help on each code to refresh the user's memory or help the user learn the system is available. The program also contains the option to remove this 'assistance' section once the system and codes have become familiar.

This simplistic approach also applies to the hardware associated with the MMS. Logically labeled ports, keys, and switches are essential to support the user before he/she even sits down. Sequential action for energizing or de-energizing the system should be prominently displayed. A quick reference to simple troubleshooting should also be readily available.

4. **Flexibility**

Nothing is more wasteful of space aboard a ship than a multi-capable system being used solely for one purpose. The installed system must have the flexibility to adapt to other uses in the ship's organization. Such uses include:

* Inventory management and control
* Personnel file maintenance
* Publication files
* Navigational planning
* Anti-Submarine Warfare acoustic analysis (Target Motion Analysis)
* Electronic signal analysis
* Communication signal analysis
* Equipment maintenance records
* Fuel and water usage analysis
* Ammunition transaction records

There are, of course, many more uses than those listed, but in order to get the maximum benefit from the MMS microcomputer it must support other applications. To occupy a major portion of a desk top necessitating its removal every time some other requirements for the desk top appear can be both physically damaging to the hardware and possibly to the person doing the removal (if it's heavy enough). It also brings up the old saying 'out of sight, out of mind' meaning if the system requires finding the computer and setting it up for each use it will soon be forgotten and unused.

5. **Reliability**

Broken components in the Navy are assigned priority for repair according to their essential need in the performance of the ship's mission. A computer system for paperwork would not command a very high priority. Therefore, any system installed must be reliable in hardware performance. Mistrust of a system, as a result of frequent problems, leads to nonuse. The same applies to the Message Management System program itself. It must be reliable in it's consistent performance and not susceptible to

user damage, or damage to user files. Unexpected deletion of messages or files either by user error or system error is unforgivable. Error recovery is a vital component of the system. Restoration of erroneously erased files (within limits) must be incorporated into the system. As the common Navy saying goes 'Make it Boatswain mate proof'. In other words, expect the user to do the unexpected and save him from himself.

6. Database Requirements

a. PLADS (Plain Language Addresses)

All Navy messages use the Plain Language Addresses in listing initiating and destination commands for naval messages. These PLADS are normally close variations on the actual command title. For example: Commander, Naval Surface Forces Pacific in San Diego, California is written as COMNAVSURFPAC SAN DIEGO CA; and Commander Third Fleet is written COMTHIRDFLT. These PLADS are electronically interpreted into routing codes by the Navy's communication stations and transmitted to the designated commands. Errors in the PLADs can result in either human intervention for correction (which slows the system down greatly) or non-deliverance of the message. Either case is undesirable, but common with the vast number of commands in the Navy and the thousands of PLADS in use. There are periodic changes, additions, and deletions to the PLAD list and each command is provided with a message listing these revisions. The PLAD list itself is a computerized double-column listing about 3 inches deep.

A database, capable of being periodically updated, that can be used much like a word processing spelling checker would greatly enhance the reliability and efficiency of the system. This would still not relieve the communication personnel of their requirement to verify all PLADS, but it would significantly reduce the chance for error, thus saving message transmission time and human intervention.

b. Forms.

One of the primary reasons for using a computer based message processing system is the abundance of formatted messages that are required by the Navy. A significant majority of these messages are formatted for computer reading and data correlation. An abbreviated list of such forms would be as follows:

* Casualty Reporting System (CASREPS)
* Movement Reporting System (MOVREPS)
* Operational Intelligence Reporting System (RAINFORMS)
* Supply Requisitions (MILSTRIPS)
* Fuel Usage Reports (NEURS)

* Personnel Sailing Report (SHIP'S DIARY)
* Unit Status Report (UNITREPS)
* General Operational Reports (OPGENS)
* Logistic Requirements Request (LOGREQS)
* Replenishment At Sea System (RAS)

In addition to those listed above there are many more regularly required or repetitious reports than can be considered formatted messages. Situational requirements may alter some of the formats and add others so the FORMS file must be dynamic to accept these changes easily. Additional information in a separate paragraph, changes in chain of command that alter addressees, and out-of-area assignments that alter forms are a few of the reasons for FORMS alteration.

In keeping with the simplistic approach, the FORM file should be as extensive as possible when first established and easily modified by the user. As each user would have his own FORM file, the size of the file would not be unmanageable for the various users. For example, the Supply Officer would normally only keep Supply FORMS in his file since the requirement for him to be action officer on a Operational message would rarely occur.

c. Spelling

There are very few totally competent spellers in the Navy that don't have to check a dictionary at least once during the preparation of a message. Naval terminology and abbreviations compound the problem of generating error free messages. A means to check spelling would have to be a requirement for the message processing system. A command's performance is often judged on how it appears in its messages. Error ridden messages, of course, give the negative impression concerning attention to detail and pride in appearance.

As with the FORM file, the spelling checker must be adaptable to meet the ever changing abbreviations used by the Navy. Once the user has verified that a word is spelled correctly it should be added to the systems spelling file for future reference.

C. DESIGN METHODOLOGY

The methodology used in the design of the Message Management System is a slight variation of the the Composite/Structured Design introduced by Glenford J. Myers [Ref. 5]. The methodology is actually composed of two distinct design methods with a common theme; Structured Design and Hierarchical Input Process Output

Design. Composite Structured Design focuses on three universal means in reducing the complexity of the design representation by:

1) Partitioning of the system into parts having identifiable and understandable boundaries;
2) Representing the system as a hierarchy, and;
3) Maximizing the independence among the parts of the system.

1. Partitioning

The act of partitioning a program into individual components can reduce its complexity to some degree. One objective of partitioning is to reduce the number of factors that a human mind has to keep track of simultaneously in order to comprehend the program. A more powerful justification is that partitioning creates a number of well-defined, documented boundaries within the system. The boundaries, or interfaces, are invaluable in the comprehension of the program.

2. Hierarchy

The concept of hierarchical organization is of vital importance in both understanding and constructing the system. This again deals with the human mind's cognitive limit on the small number of facts which it can simultaneously process. Hierarchical views aid in understanding by directing our span of attention and allowing us to cope with the system at various levels of detail.

For the same reasons, hierarchies aid the construction of the system by allowing us to separate our ideas and to deal with increasing amounts of detail.

3. Independence

The most important consideration in good design, and the single idea upon which most composite design is based, is high module independence. The objective is not simply partitioning the program into a hierarchy, but determining how to partition a program into a hierarchical structure such that each module is as independent from all other modules as possible.

An important part of composite design is the set of measurements of module independence. The first is Modular Strength (relationships within a module) which occurs in various ways. The "Message Manager" system was composed to have functional strength within the modules which gives the design high cohesion.

The second measurement is Module Coupling (relationship between Modules). The prefered relationship in this program design was Data Coupling where each module simply passes application data to the next lower level module.

D. HIERARCHICAL INPUT PROCESS OUTPUT (HIPO)

The Hierarchical Input Process Output portion of the composite/ structured design applies the design concepts of functional strength and data coupling to the functional decomposition and graphic techniques of HIPO . This provides a single methodology that allows an application design such as the "Message Manager" to develop in an orderly manner from a clear statement of the requirements to an intelligible, well constructed set of application functions. The program design is implemented in a top-down manner with three levels of detail commencing with the broadest to the finest level as follows:

* System (Control)
* Program (Decision)
* Module (Function)

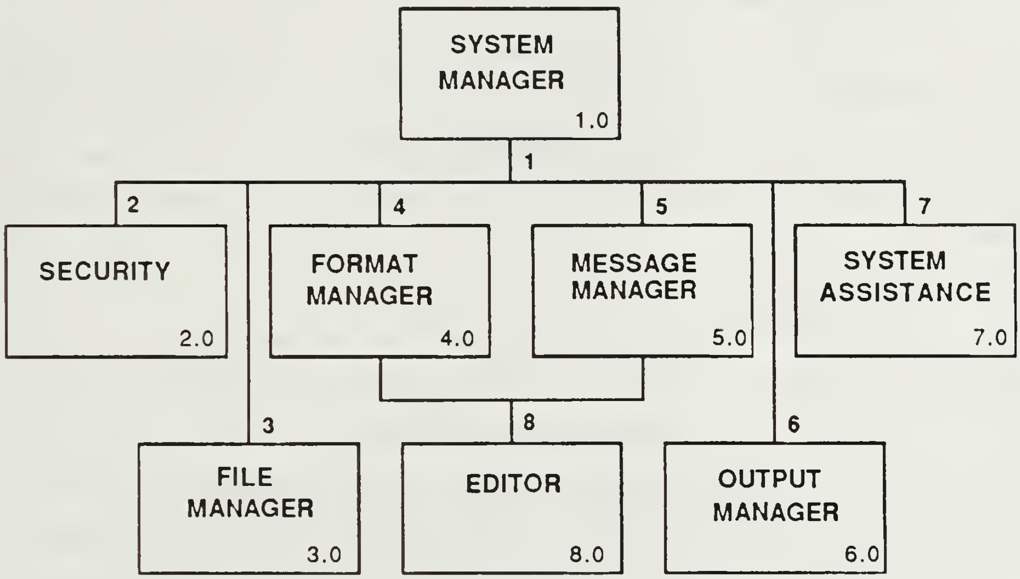
These three levels are conceptual, and are not a physical part of the design. Each conceptual level may represent multiple levels on the hierarchy chart, and any given module in a structure may be both the bottom of one conceptual level and the top of the next level.

E. LOGICAL DESCRIPTION

The first logical step in designing the Message Management System is the logical partitioning of the system requirements into functional areas or programs. The seven functional areas were determined to be:

* Security - Access Control and File Encryption.
* File Management - File manipulation and housekeeping.
* Format Construction - Creation of format mask for message input.
* Message Construction - Combining user input with format mask.
* Text Editing - Functional word processing and form compliance
* Message Generation (Output) - Peripheral status and output form.
* System Assistance - Information and verification services.

Step two was the transformation of the logical relationships of the functional areas into a structure. The system structure depicted in Figure 4.1 is the graphic representation of the hierarchical relationships of the functional programs that make up the Message Management system. Figure 4.1 shows the first level of decomposition. Further logical structures for the second level of decomposition of each program in the system structure are provided in Appendices A through G.



#	INPUT	OUTPUT
1	MODE	
2		MODE
3		MESSAGE , MODE
4		MESSAGE , MODE
5	MESSAGE	MESSAGE , MODE
6	MESSAGE	MESSAGE, MODE
7	MESSAGE	MODE
8	MESSAGE	MESSAGE

Figure 4.1 System Structure Chart.

Data flow between the modules of the system structure are provided in the tableau located at the bottom right corner of the figure. The flow number on the tableau corresponds to the numbers located on the structure chart.

F. PHYSICAL DESCRIPTION

1. System Module(1.0)

The system module provides for three very important functions of a software application program: 1) Program Initialization, 2) Program Control, and 3) Program Termination. Program Initialization provides for the program entry point, the initialization of parameters for use by the system, and the initial screen display to the user.

a. Screen Display

The screen display is actually made up of three distinct areas which are altered by each program as necessary to reflect status, file content, or user options. As can be seen in Figure 4.2, the top portion of the screen is called the Program Status area and reflects the working filename, filetype, mode(program), and action that the system is currently performing. The middle portion of the screen is the File Display area where files are viewed, manipulated, edited, and other such functions as are available. The bottom portion of the screen is called the Command Line area. Its function is to display user options for actions that are available from the current status of the system.

An additonal function of the command entry area is error message display. The bottom line of the screen is reserved for error messages generated by invalid user commands or input. All error messages appear in this same location and are preceded by a sound signal to alert the user.

b. Program Control

Program control, in the case of the Message Management System is a continual loop through the functional programs which are chosen by both system logic and user choice. Figure 4.3 depicts the routing loop of the system which is terminated (normally) by user's choice. As can be seen, the Security function is not contained within the loop as its function at this point in the system is to determine whether the user has authorized access to the system.

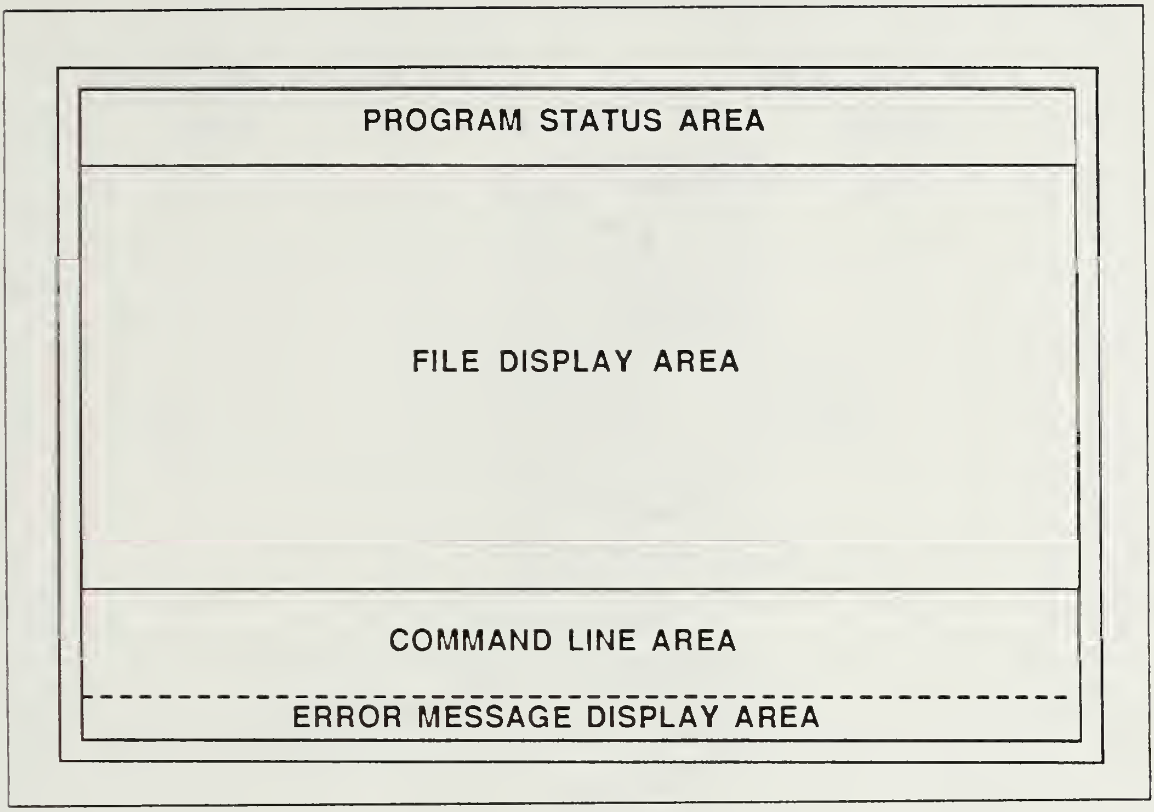


Figure 4.2 System Display Screen.

c. Program Termination

Program termination cleans up any loose ends of the system and returns the user to the operating system.

The HIPO diagram depicting the System Module is seen in Figure 4.4 The three areas of the diagram represent the Input required to perform the indicated Process and the resultant Output. As can be seen, the output of one process can be the input to another. The processes are listed in sequential completion order. Loops, or conditional processes are not shown nor are not handling procedures. These would all be contained in a more detailed design as the diagram is decomposed by each process.

G. PROGRAM DESCRIPTION

1. Security Program (2.0)

The Security program's Function is to provide access control to the system. This is accomplished through the comparison of a user provided password to an Access

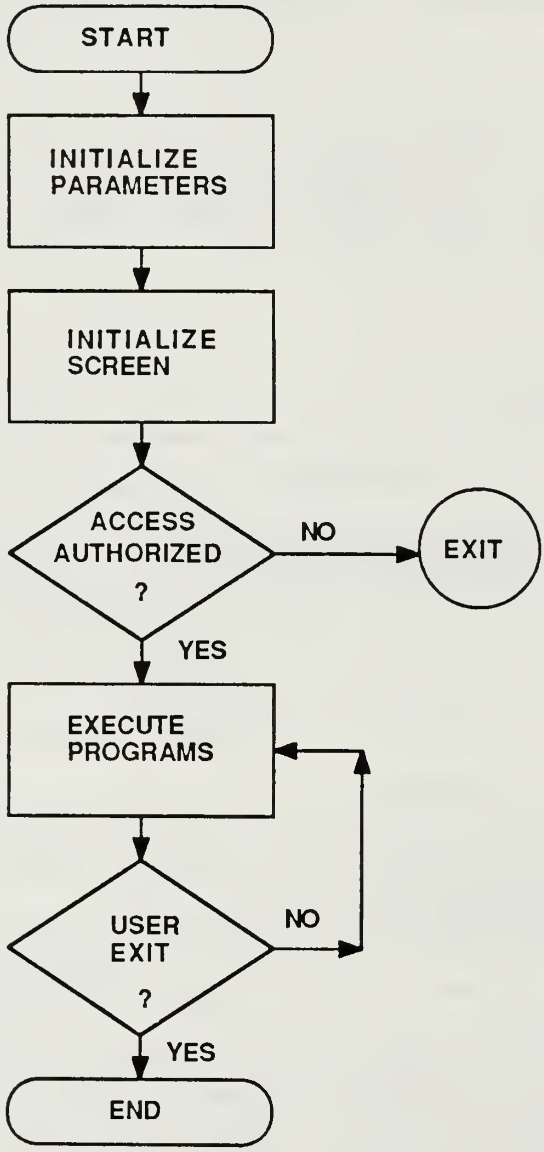


Figure 4.3 System Module Logic Flowchart.

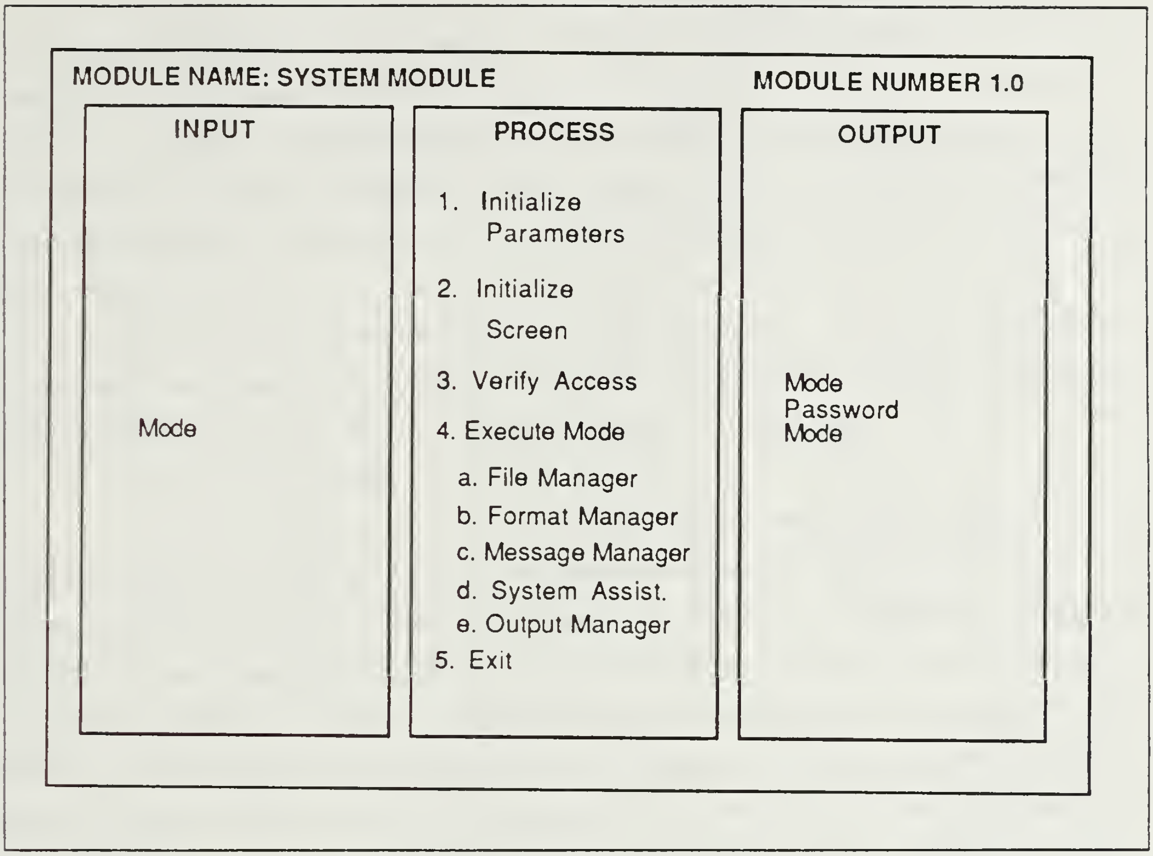


Figure 4.4 System HIPO diagram.

List File. Successful comparison will allow the user full access to the program. Unsuccessful comparison will generate an "Access Denied" message and terminate the program. The Access List File can be changed, added to, or deleted from to allow multiple users. Alterations to the Access List File is accomplished through the System Assistance Program.

2. **File Management Program (3.0)**

The File Management program provides the "Home" Command portion of the screen from which the user branches into other modes, actions, or program termination. The module itself controls such file actions as Rename, Copy, Delete, Directory, or Open a message or format as desired. It is from this program that the user can view his file directory and select an existing file or open a new file to work with. The selected file is then available for whatever mode or action the user selects to process the file.

3. **Format Manager Program (4.0)**

The Format Manager Program provides the flexibility in the Message Management system by allowing the user to alter existing formats to unique situations or to create entirely new formats for additional message drafting requirements. Formats are divided into two parts, the first being the Message Form Line which becomes a part of the completed message, and secondly a Comment section for explanation of the Message Form Line, its input, and its use. The Comment section allows format use by others who may not fully understand the proper use of the Message Form Line. The Format Program is invoked only when a new "Format" type file is opened. Full keyboard function and text editing commands via the Editor program are available to the user while in the Format mode.

4. **Message Manager Program (5.0)**

The Message Manager Program is the user's guide to writing a formatted message. The "Form Line " prompts and associated comments are obtained from the related Format file and are sequentially controlled by this program directing the user in the step by step completion of a Naval Message. As the user provides input to each form line the program verifies proper input (alphanumeric, field width, etc.) and cycles automatically to the next form line. Free ended form lines require the user to indicate input completion and advancement to the next form line.

5. **Output Manager Program (6.0)**

The Message Preparation Program controls the generation of the system output in final "Hardcopy" forms of standard print, paper tape, or DD173 format. The program accomplishes the generation through control of the attached peripherals and the routing of the designated file to system ports. The Command portion of the screen in this mode reflects the ON/OFF status of the two Types of peripherals (Paper and Punched Paper Tape) and the ON/OFF status of the desired paper form (Standard or DD173). Users can alter peripheral or paper form status before actually outputing the message. The program will then produce the desired results and return the user to the "Home" screen and the File management program for further user options.

6. **System Assistance Program (7.0)**

The System Assistance Program provides the user with a source of information and functions to help in the preparation of a message or in the understanding of the use of the Message Management system. The program gives the user access to two libraries; one for Plain Language Addressees (PLAs) and the other

for Standard Subject Identification Code (SSIC). Additionally, the program can verify a message's addressees against the PLA library, indicate addressees not found, and update the library with new addresses.

The system assistance program also controls the system access list to allow passwords to be added, changed, or deleted as required to cover the number of users of the system. Group passwords can be installed for multiple users of the same message files.

Lastly, the system assistance program provides a system tutorial for new users, and a help facility to provide the user with additional information on the choices made available to the user in the Command portion of the screen.

7. Editor Program (8.0)

The Editor program controls the text input, line size and user editing functions of the message or format. Editing functions have been kept relatively simple since freedom in message styles is limited and the need for intricate editing capabilities does not exist. Four basic editing functions are covered; line movement, line copying, line inserting, and line deletion. Character insertion and deletion are accomplished by giving the user a full functioning keyboard for cursor movement and insert/deletion keys. A user controlled "word wrap" capability is included to facilitate typing and format control.

H. SUMMARY

The design presented in this chapter and in the indicated appendices was sufficiently detailed to enable experienced programmers to move into more detailed coding levels. Further detailed design of the system with regard to error handling and recovery would be required prior to the implementation of the system as a "turnkey" system. The seven functional programs that make up the system are well within the existing programing skills of a competent programmer and as entities in themselves portable to other system applications. The requirements of utility, portability and understandability are perceived to have been achieved. Utility was achieved through the favorable comparison of the system logic to existing message processes. Portability was achieved through the total system concept that all required functions be contained within the system and not be specific operating system dependent. Lastly, understandability was achieved through the logical partitioning and functional independence of the system.

V. RECOMMENDATIONS AND SUMMARY

A. IMPLEMENTATION RECOMMENDATIONS

In the process of implementing the Message Management system, various limitations or restrictions are reccommended in order to maintain the scope of the design within its intended functions. Listed below are the significant limitations or restrictions which affected the design process.

1. Color

The use of color in the design was restricted largly due to the lighting aspects of the expected hardware locations onboard ship. Operational spaces which are manned on a 24-hour basis such as the ship's Combat Information Center (CIC) are possible locations of microcomputers for message generation. These spaces require night lighting which consists of either red or blue lights. The use of either color in the system design would cause those colors to 'disappear' on the screen.

2. Graphics

The use of graphics is not required due to the perceived nature of business being conducted with the system that precludes any advantages gained by graphical representation of the processes. The tranditional use of transmittable text additionally restricts the use of graphics.

B. CODING LANGUAGE

The coding languages recommended for the implementation of the Message Management System are the C language and dBASE III language. The C language is a high level, procedural language developed by Dennis Ritchie at Bell Telephone laboratories in the early 1970's. The language has several distinct advantages that relate directly to the form and objectives of the Message Management System design. These advantages include:

* System Independence - The C language requires no operating system services, thus making programs written in C highly portable.

* Modularity - C supports one style of routine, the external function, which calls parameters by value. It allows limited forms of privacy by using storage class static within files. These features readily support user-defined libraries of functions and modular programing.

* High Efficiency - C compliers are generally able to translate source code into efficient machine instructions. C language data and control mechanisms are well matched to most small computers and microcomputers which is the primary goal of the Message Management system design.

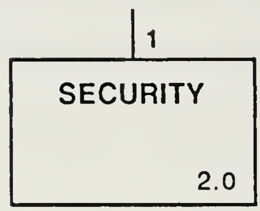
Another aspect of the C language recommending it for implementation of the Message Management system is it's current use as the primary system language for UNIX and AT&T systems. Expansion of the Message Management system to an on-line electronic message system would be quite simple. Such expansion would require it to be compatible with existing telecommunication requirements. The use of C would give the system an advantage in making the transition.

dBASE III is an industry-standard database management language designed for use on microcomputers. It is capable of interfacing effectively with the C language and significantly adds to the file and database management required by the Message Management System. The use of DBASE III is recommended specifically for the File, Message, and Format Modules, and additionally for the System Assistance module libraries and tutor.

C. SUMMARY

The preliminary system analysis and design presented in this thesis is largely the result of my past experience in working with the Naval Communication System in the capacity of a very frequent message drafter. Variations of the procedures recommended herein have been observed in actual operation with varying success. The impending implementation of JINTACCS, which is a highly formatted message type, makes the need for a versatile, microcomputer-based message writer even more urgent. It is hoped the implementation of this design will be a valuable tool to the message drafter in this environment.

APPENDIX A
SECURITY PROGRAM



#	INPUT	OUTPUT
1		MODE

Figure A.1 Security Structure Chart.

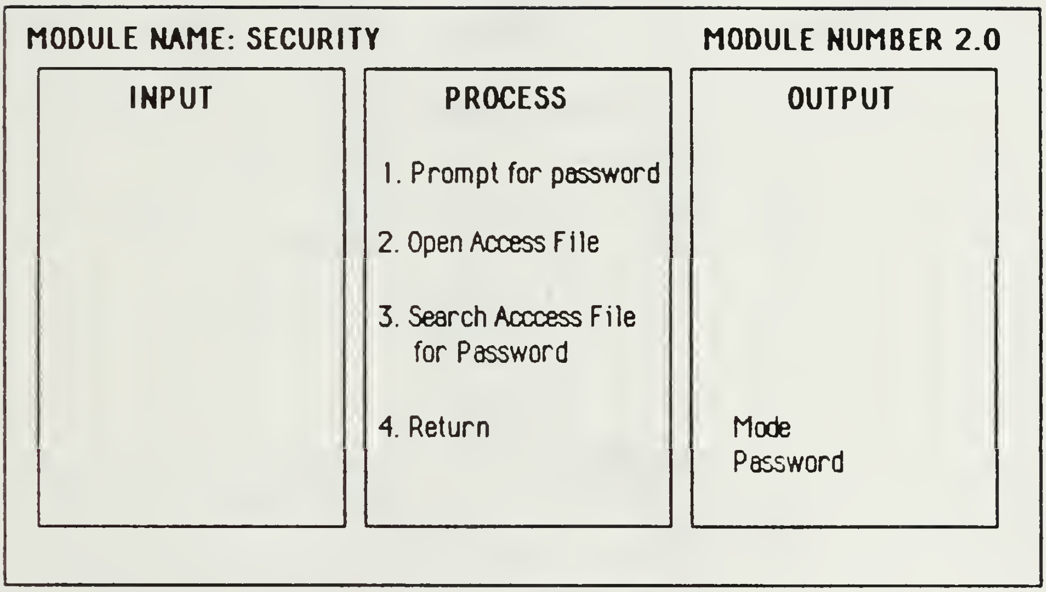
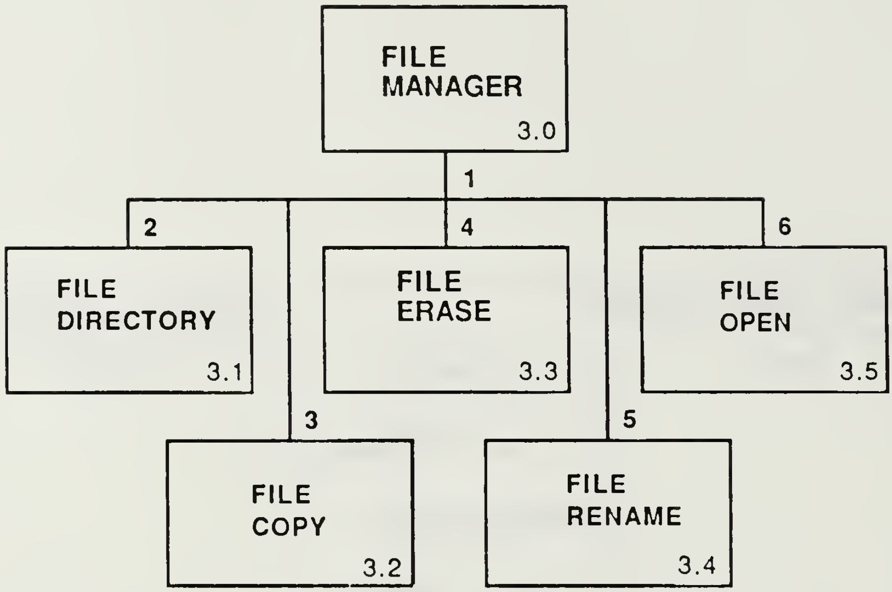


Figure A.2 Security HIPO Chart.

APPENDIX B
FILE MANAGER PROGRAM



#	INPUT	OUTPUT
1		
2		
3		
4		
5		
6		MESSAGE, MODE

Figure B.1 File Manager Structure Chart.

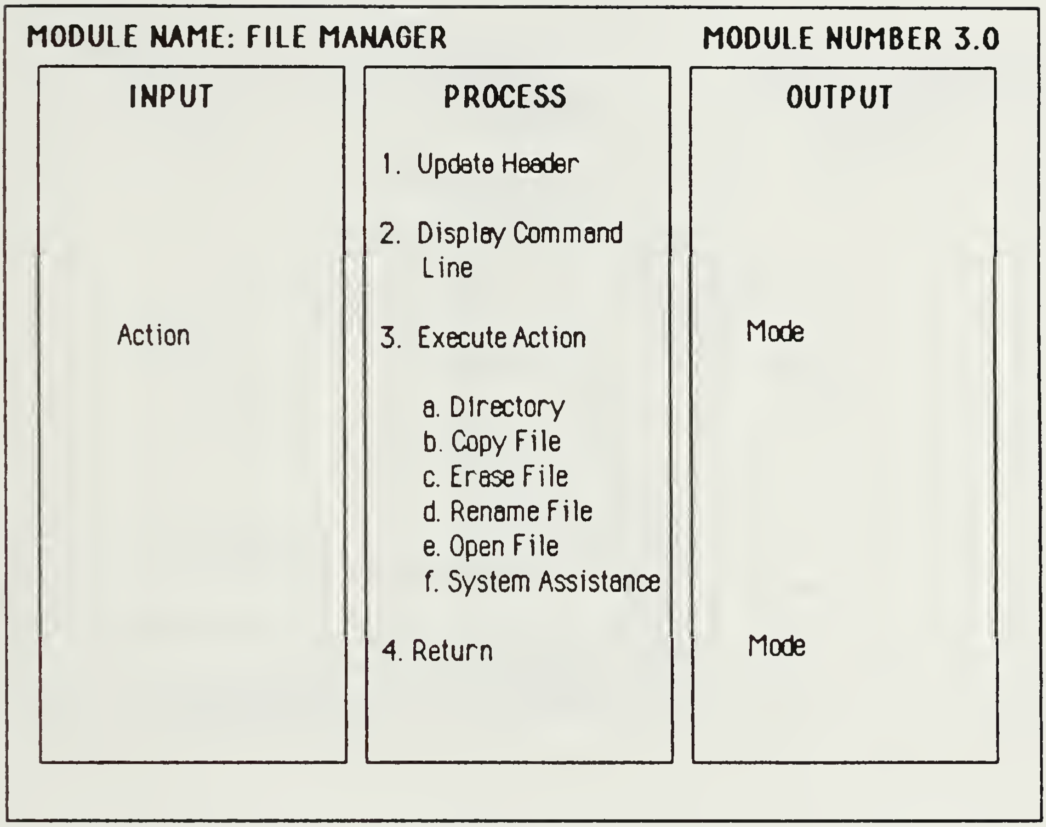
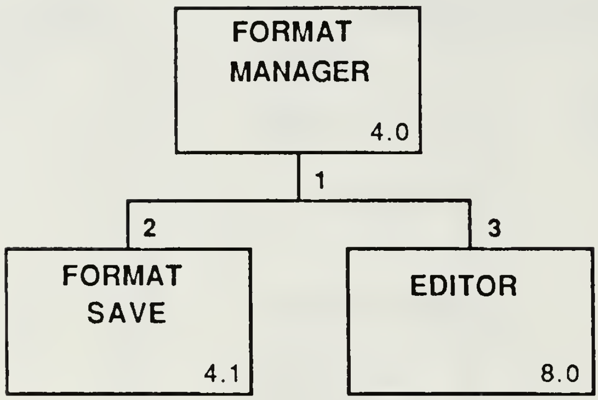


Figure B.2 File Manager HIPO Chart.

APPENDIX C
FORMAT MANAGER PROGRAM



#	INPUT	OUTPUT
1		
2	MESSAGE	
3	MESSAGE	MESSAGE

Figure C.1 Format Manager Structure Chart.

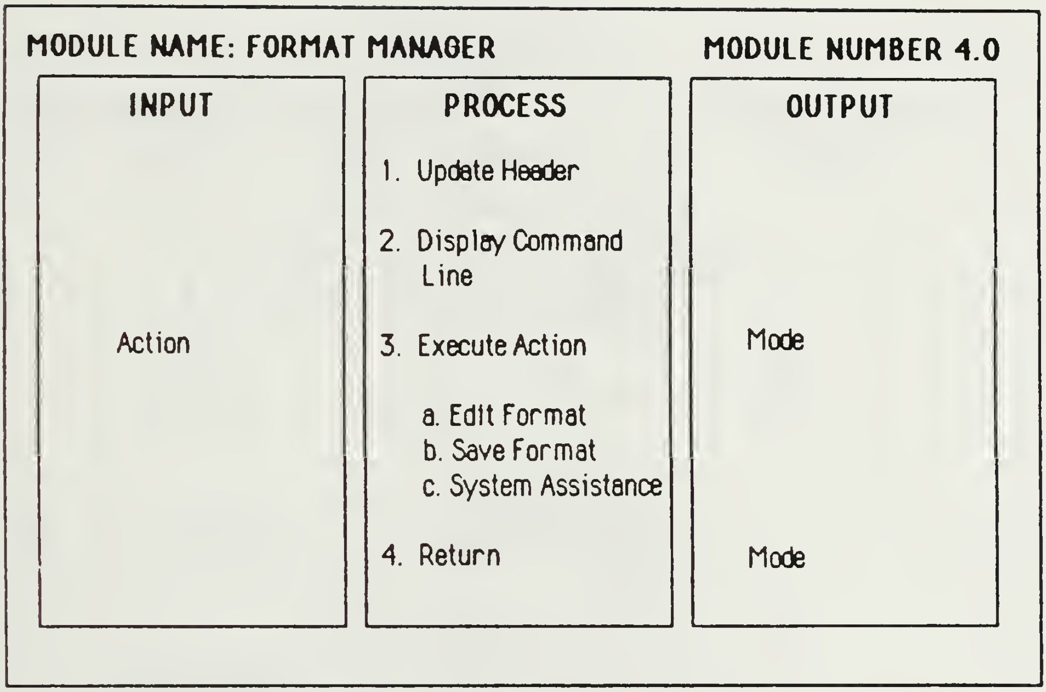
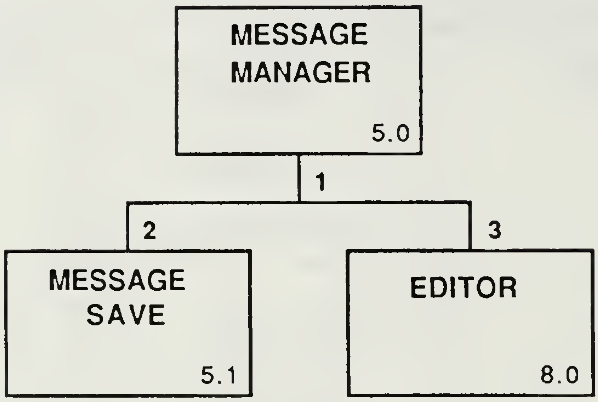


Figure C.2 Format Manager HIPO CHART.

APPENDIX D
MESSAGE MANAGER PROGRAM



#	INPUT	OUTPUT
1		
2	MESSAGE	
3	MESSAGE	MESSAGE

Figure D.1 Message Manager Structure Chart.

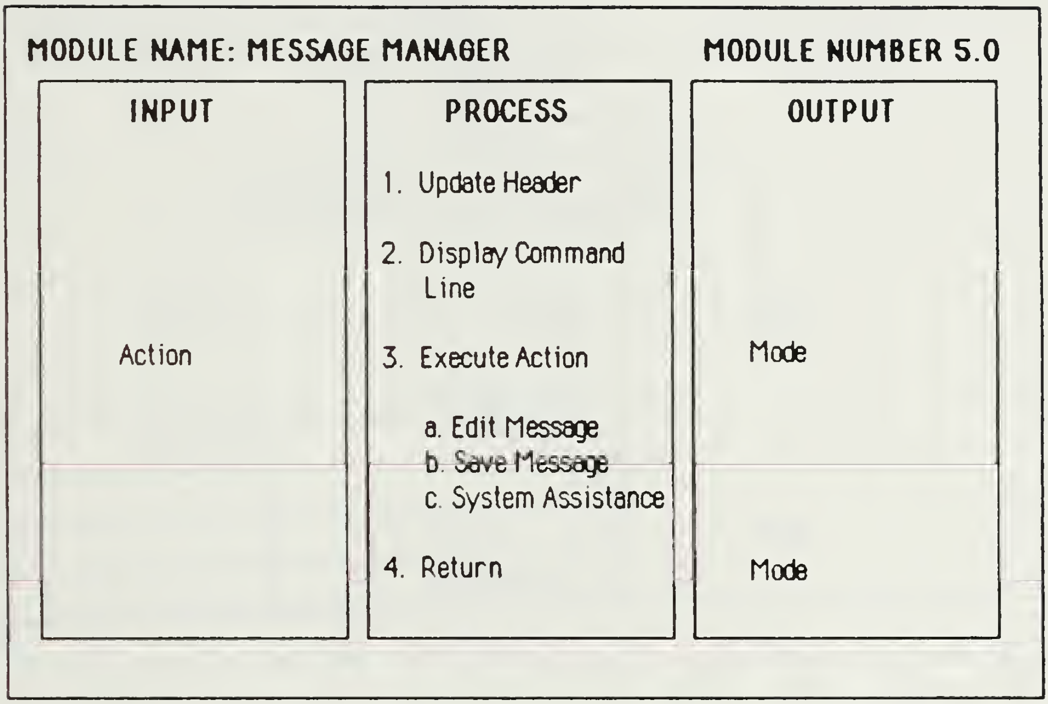
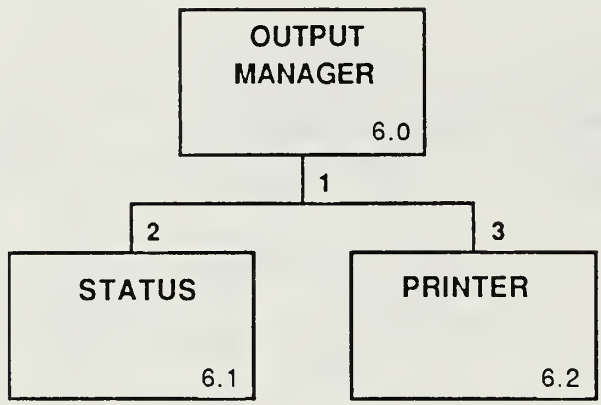


Figure D.2 Message Manager HIPO Chart.

APPENDIX E
OUTPUT MANAGER PROGRAM



#	INPUT	OUTPUT
1		
2		
3	MESSAGE	

Figure E.1 Output Manager Structure Chart.

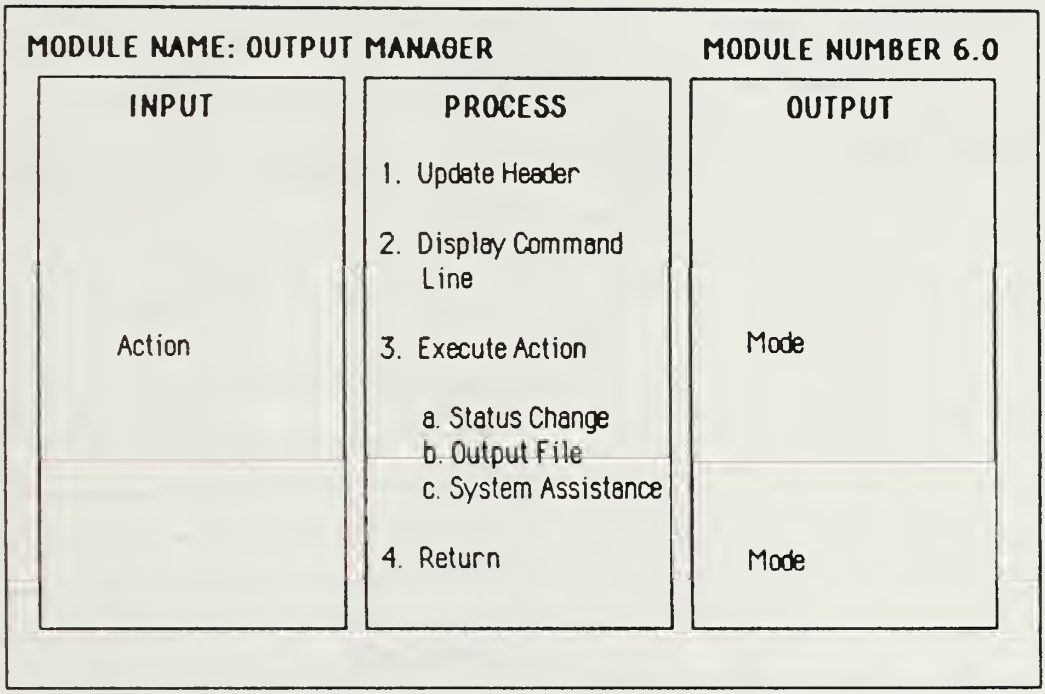
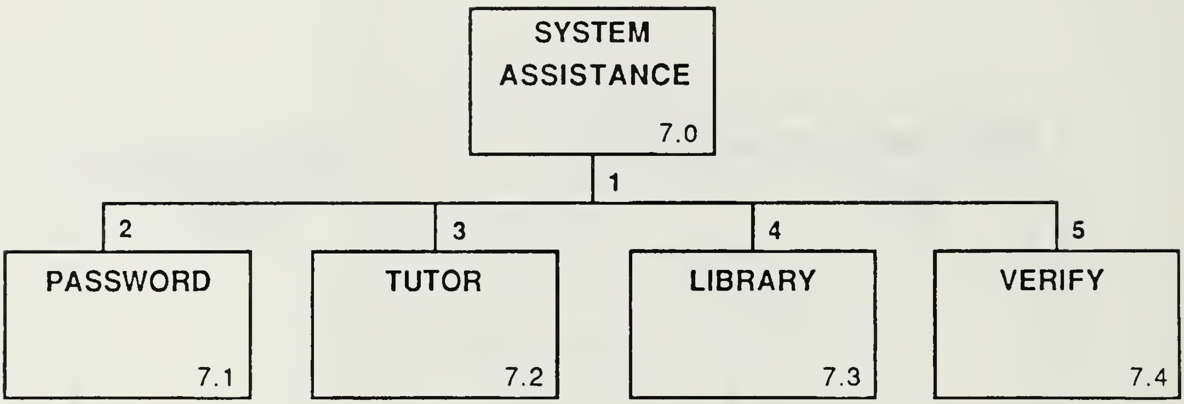


Figure E.2 Output Manager HIPO Chart.

APPENDIX F
SYSTEM ASSISTANCE PROGRAM



#	INPUT	OUTPUT
1		
2		
3		
4		
5	MESSAGE	

Figure F.1 System Assistance Structure Chart.

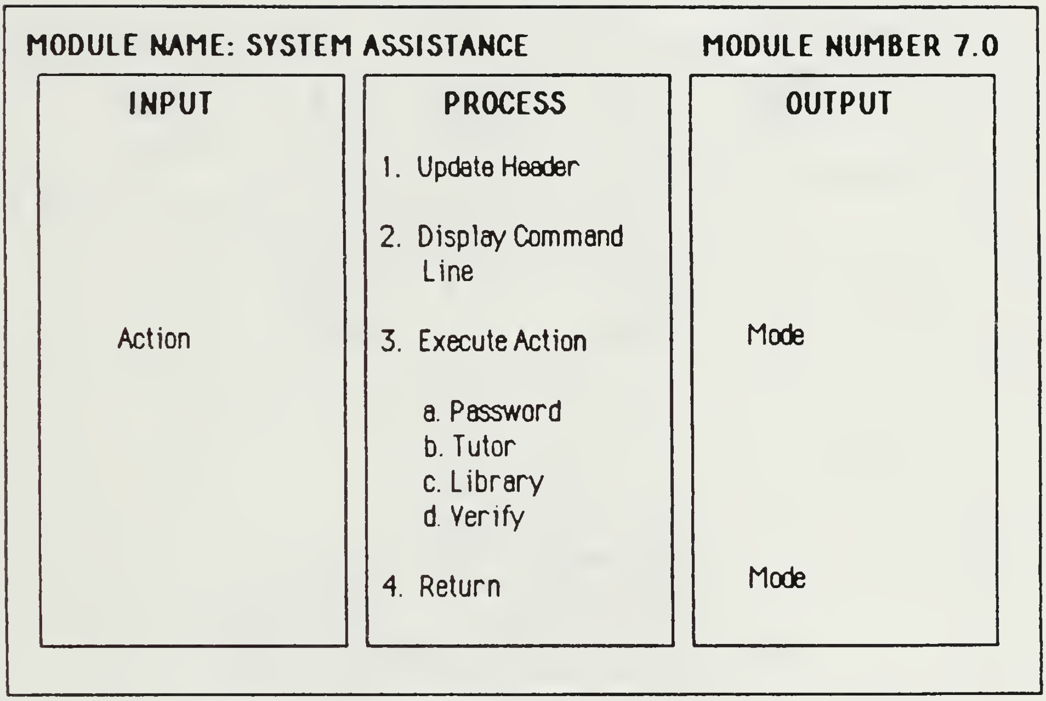
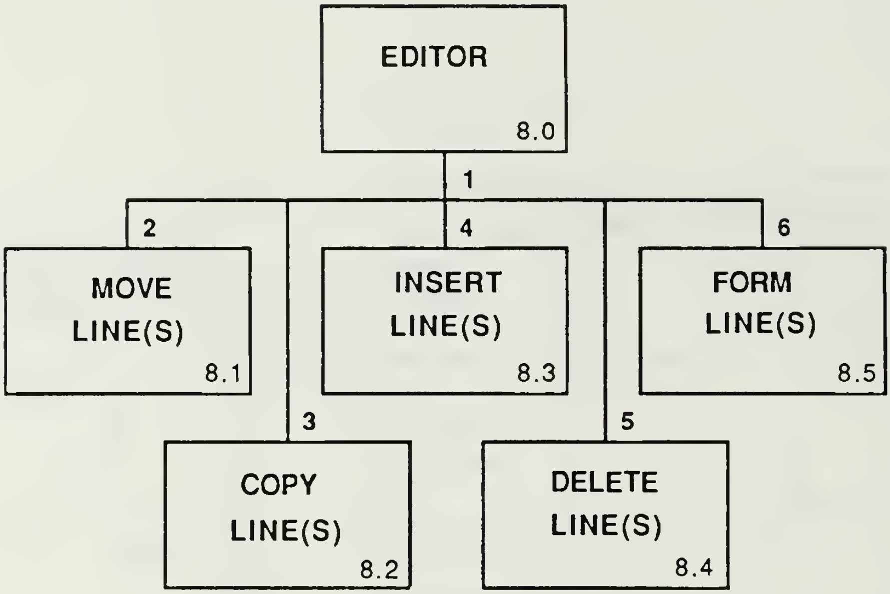


Figure F.2 System Assistance HIPO Chart.

APPENDIX G
EDITOR PROGRAM



#	INPUT	OUTPUT
1	MESSAGE	MESSAGE
2	MESSAGE	MESSAGE
3	MESSAGE	MESSAGE
4	MESSAGE	MESSAGE
5	MESSAGE	MESSAGE
6	MESSAGE	MESSAGE

Figure G.1 Editor Structure Chart.

MODULE NAME: EDITOR **MODULE NUMBER 8.0**

INPUT	PROCESS	OUTPUT
	1. Update Header	
	2. Display Command Line	
Action	3. Execute Action	Mode
	a. Input Text b. Move Line(s) c. Copy Line(s) d. Insert Line(s) e. Delete Line(s) f. Form Line(s)	
	4. Return	Mode

Figure G.2 Editor HIPO CHart.

LIST OF REFERENCES

1. Chief of Naval Operations, *Naval Telecommunications Automation Program Subsystem*, October 1982.

2. Chief of Naval Operations, *Shipboard Communication Automation Review*, 30 October 1978

3. Naval Telecommunications Command, *NTP-4(B): Fleet Communications (U)*, November 1980 (CONFIDENTIAL Document).

4. Naval Telecommunication Command, *LDMX NAVCOMPARS Performance Analysis: 1985 Comparative Study Trends and Projections*, 1 June 1986.

5. Meyers, Glenford J., *Composite/Structure Design*, Van Nostrand Reinhold, 1978

BIBLIOGRAPHY

Naval Electronics Laboratory Center, *Proposal for a Family of Small-Scale Message Processing Systems (SSMPS)*, 17 March 1972.

Bureau of Naval Personnel, *NAVPERS 10780-B: The Communications Officer (U)*, 1970 (CONFIDENTIAL Document).

Report of the Special Subcommittee on Defense Communications (Mollohan Report), *Review of Department of Defense Worldwide Communications: Phase II*, 12 October 1972.

Naval Command Systems Support Activity, *NAVCOSSACT Document No. 84A005 TR-01: Naval Telecommunications Performance Evaluation System*, October 1976.

William E. Riddle and Jack C. Wileden, *Tutorial on Software System Design: Description and Analysis*, IEEE Computer Society Press, 1983.

Peter Freeman and Anthony I. Wasserman, *Tutorial on Software Design Techniques, 4th Ed.*, IEEE Computer Society Press, 1983.

Rand Corporation, *Writer-To-Reader Delays in Military Communication System*, October 1979.

Martin B. Zimmerman, "The Marriage of Automation and Communications", *Signal*, January 1981.

Max Gray and Keith R. London, *Documentation Standards*, Brandon/Systems Press, Inc., 1969.

R.O. Brancolini, "Automated Intelligence Processing Systems in Support of Tactical Operations", *Signal*, March 1981.

Manny Fernandez, "Naval Shipboard Message Processing Unit", *Signal*, April 1975.

William Harper and Ed Murdock, "Electronic Writer-To-Reader System in Data (record) Communications", *Signal*, July 1975.

R.G. Howe, "LDMX NAVCOMPARS Systems", *Signal*, February 1974.

Bruce U. Glass, "Error Free Message Header Generator", *Signal*, May/June 1974.

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